Space Weather Technical Forecast

Issued on Friday, 02 December 2022 at 13:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active high energy electron fluence. Daily chance of M-flares. Slight chance G1 Minor Storms, mainly early day 3 (4th) with any CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Low with a peak flare of C8.1 peaking at 02/0920 UTC, observed from the plage area to the south of new sunspot AR3156 Hsx/alpha on the northeast limb. A small flare was also observed at the same time in AR3153 Fho/Beta, a large but mature, stable and open structured group in the southeast disc. There are three other regions on the Earth-facing disc, however these are all much smaller and simpler. No Earth-directed CMEs occurred in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind was indicative of the fast solar winds from a coronal hole. Wind speeds have been Elevated to Strong, with ACE showing wind speeds peaking at around 800 km/s, before gradually declining to below 700km/s. DSCOVR has observed slower speeds of around 500-600km/s however this disparity was likely due to density being generally below average. Total IMF Bt was generally weak between 4 and 7nT, but with a declining trend. The north-south component Bz was variable between -5nT and 6nT, at first, but also saw its magnitude decline. Phi angle was positive throughout (Away from the Sun). Geomagnetic activity was Unsettled to Active (Kp 3-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES-16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES-16 was initially at Moderate levels, then increased to high levels from 01/1415 UTC, peaking at 5880 pfu at 02/1200 UTC with an increasing trend. The associated 24 hour Fluence was dipped briefly below Active (1e8 integrated pfu) 01/1500-2100UTC, but then rose above by 02/0000 UTC. Observed fluence at 02/0000 UTC was 1.07e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, but with a daily chance of rising to Moderate with an ongoing potential for M-flares, primarily from AR3153 in the southeast.

Solar Wind / Geomagnetic Activity: Slow CME arrivals are possible, mainly early day 3 (4th), due to a filament eruption on the 29th, although confidence is low with the timing. Otherwise, ongoing fast winds from CH51/+ are expected to gradually decline through the period. Quiet to Unsettled geomagnetic activity expected with chance of Active intervals day 1 and day 2 (2nd or 3rd), easing to mainly Quiet by the end of the period in the absence of any significant CME arrival. Any arrival will bring the chance of a further spell of Active to G1/Minor Storm late day 2 or more likely day 3 (3rd or 4th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES-16, is expected to remain at Background throughout. High energy electron flux (greater than 2 MeV), as observed by GOES-16, is expected to remain predominantly High with Fluence levels persisting above the Active (1e8 integrated pfu) fluence threshold.

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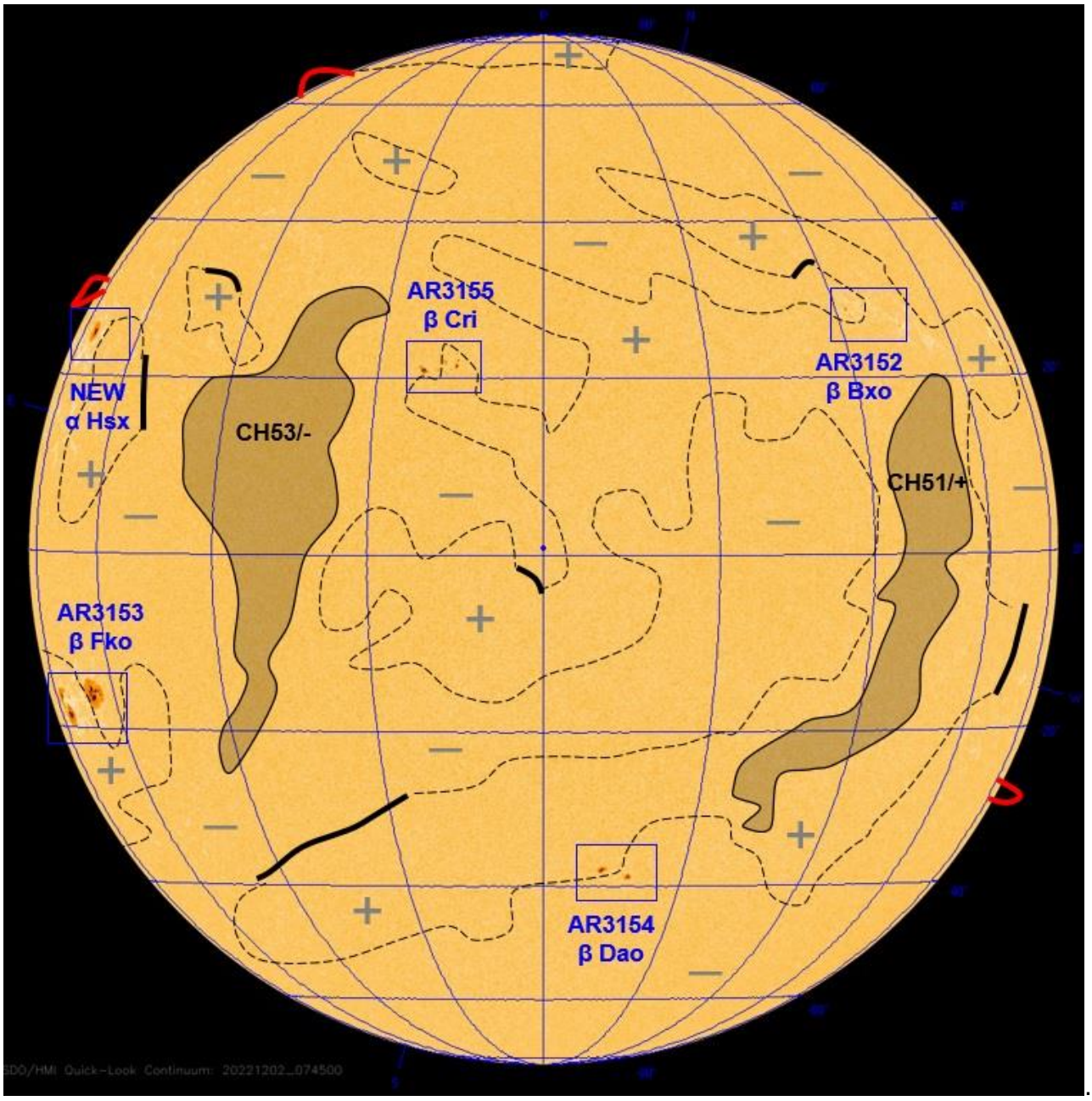
Figure 1. Solar Analysis Valid 02/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption on 29 Nov, and its associated CMEs have been assessed as slow, but with the possibility of Earth-directed components, although this is low confidence. Any arrival is most likely to occur early day 3 (4th), perhaps very late day 2 (3rd). The CME from the M1 flare of AR3152 at 01/0721 UTC is expected to miss, passing to the north and ahead of Earth.

Ongoing fast wind environment is expected to continue today (2nd), due to the high speed streams (HSS) of CH51. Current elevated to strong solar winds, in excess of 600kms at ACE, are forecast to only gradually fade through the period as indicated by MOSWOC enlil. The 27-day persistence also indicates a gradual decline, albeit slightly faster, with solar winds around 400 km/s by late day 2 (3rd). However, CH51 is a larger feature on this rotation supporting to the forecast from the Enlil model.

Quiet to Unsettled with chance of Active intervals day 1 and day 2 (2nd or 3rd), easing to mainly Quiet by the end of the period in the absence of any significant CME arrival. Any arrival will bring the chance of a further spell of Active to G1/Minor Storm late day 2 or more likely day 3 (3rd or 4th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/1246 and 30/0730	Partial	Filament	SE	300km/s and 320km/s	04/0600 +/- 9houts	Modelled as 2 CMEs. Limited shock expected. Low confidence.

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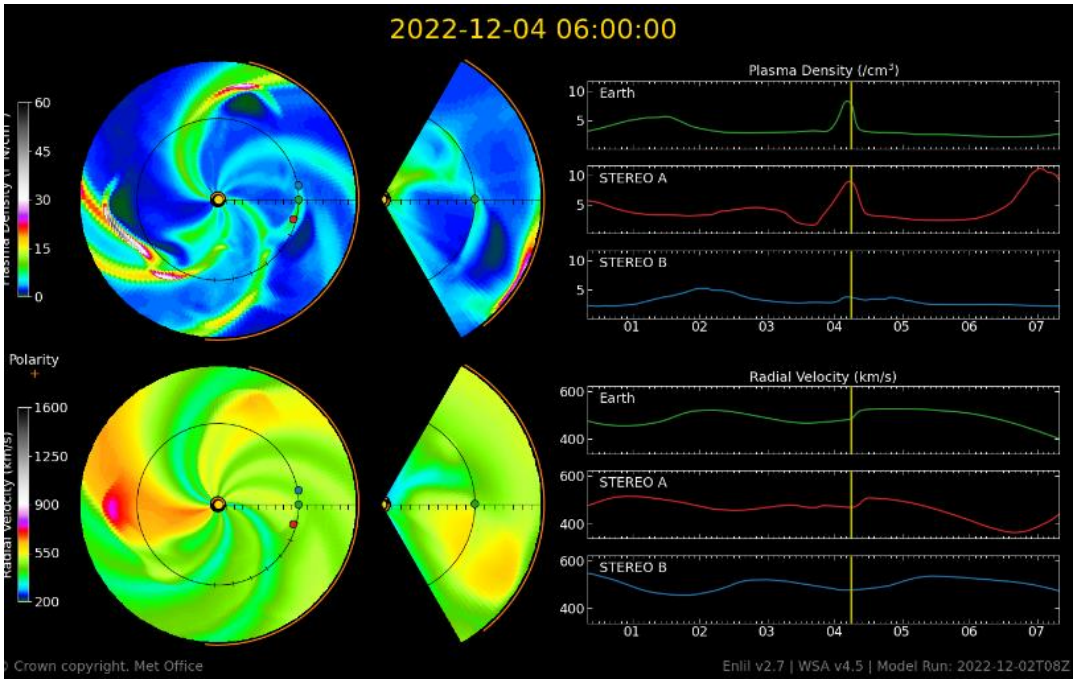
Figure 2a: ENLIL and ensemble.



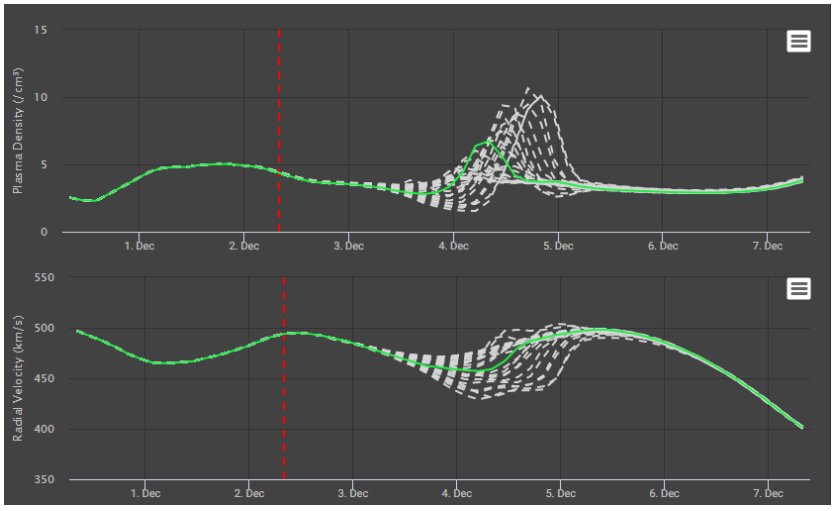
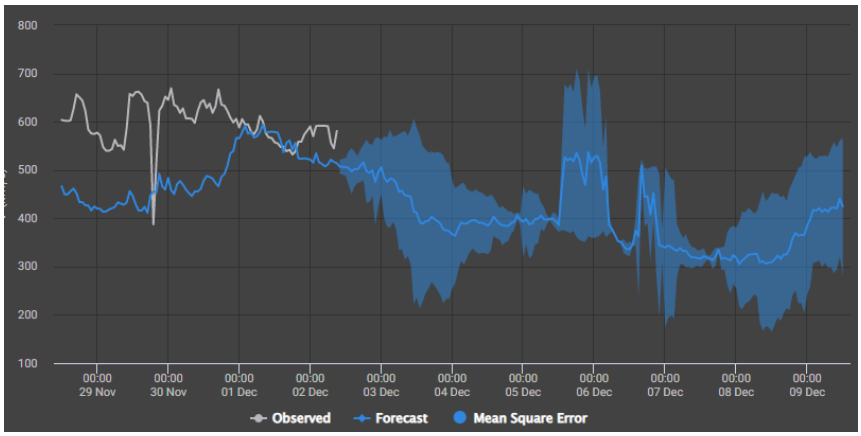


Figure 2b: Solar Wind Persistence Model



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Radio Blackouts - X-Ray Flares:

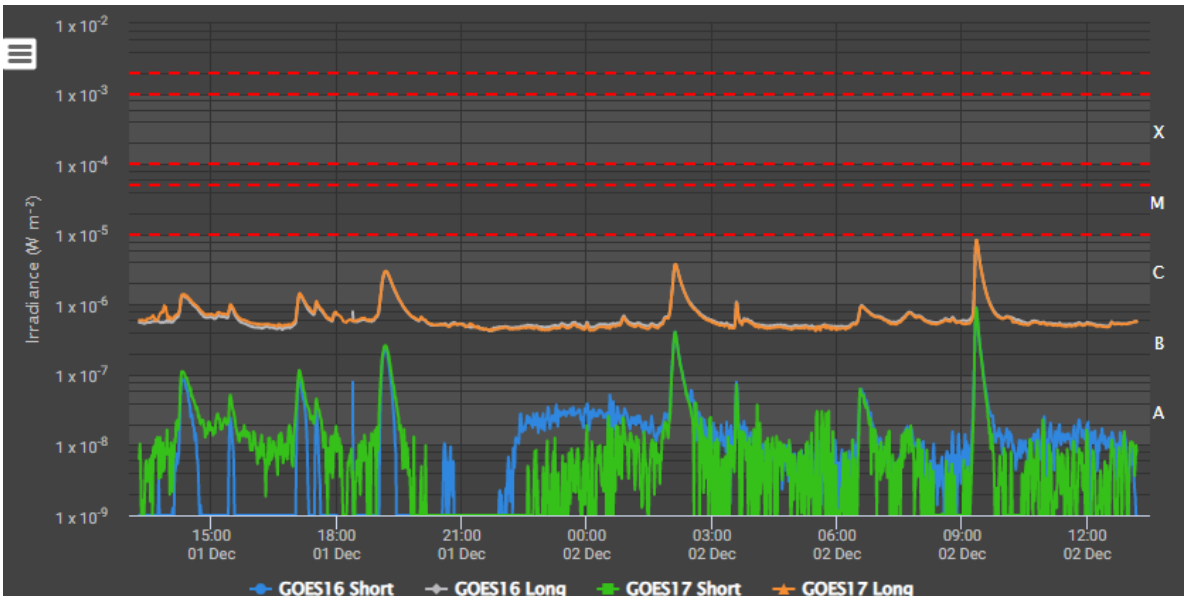
Solar activity is forecast to be Low, with further C-flares expected, and a daily chance of rising to Moderate with isolated M-flares possible.

This is primarily due to AR3153 Fho/Beta in the southeast. This has been moving towards a clearer viewing angle, with confidence increasing for a relatively simple, albeit large spot with a mature and currently stable bipolar east-to-west aligned field. Despite this, the spot does contain a large amount of potential energy giving the potential for notable flaring should any destabilisation occur.

There are four other sunspot regions, however these are all generally smaller and less likely to give significant flares. The two central disc regions AR3154 Dao/Beta in the south and AR3155 Cri/Beta in the north have only exhibited slow development, whilst AR3152 Bxo/Beta in the northwest remains simple after its M1.0 flare on the 1st Dec. AR3156 Hsx/alpha near the northeast limb appears to be a mature spot, set amongst a bright area of plage, although there is the potential for more spots to rotate onto the disc given the bright signal for this area on STEREO A euvi.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES-16/17 X-ray flux



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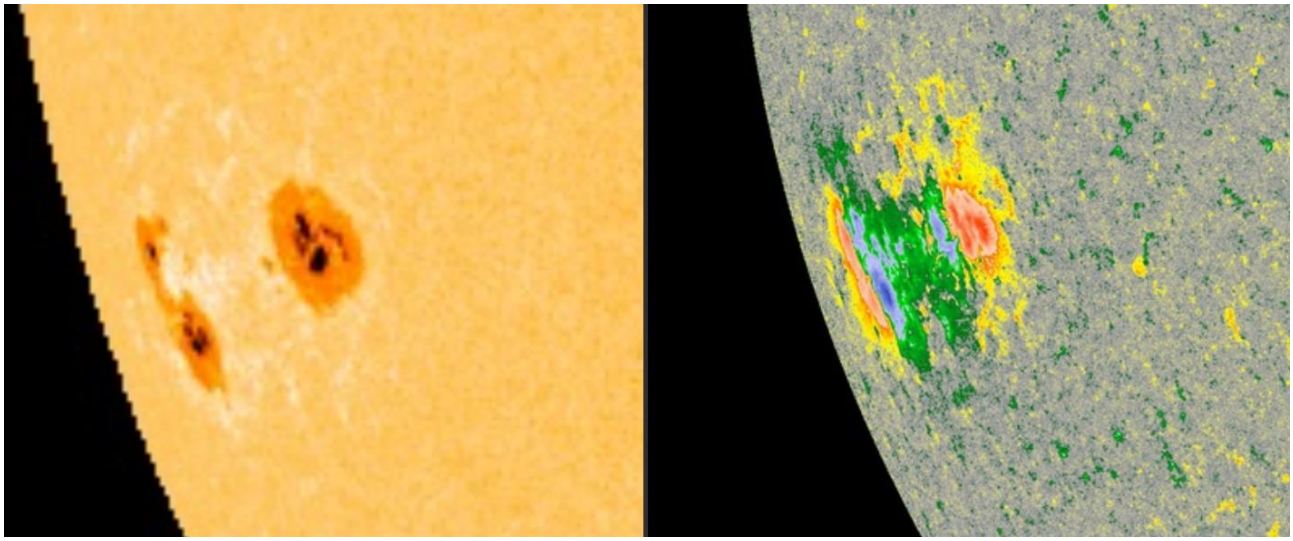
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16, is currently at background levels and is expected to remain at this level throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO HMI Intensitygram and Magnetogram of AR3153



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, is currently at High levels (above 1000 pfu) and expected to persist at this level for much of the period, with a potential increasing trend. There is a chance of a drop out early day 3 (4th) due to any potential CME arrival.

Consequently the associated Fluence levels are currently above the Active (1e8 integrated pfu) and are expected to increase through the following days as the HSS wanes. Confidence is high that the fluence will remain predominantly above Active with only a reduction in confidence by day 4 (5th). REFM has struggled to handle the recent fast wind arrivals, however it is now giving good guidance for Active fluence to persist.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	100	95	80
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	10	10	5

Figure 5: GOES >2MeV Electron Flux and Fluence with REFM and recurrence.

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